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BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP
1279 Oakmead Parkway
Sunnyvale, CA 94085-4040

EXAMINER	
PETERSON, CHRISTOPHER K	

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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/603,729
Filing Date: June 24, 2003
Appellant(s): YAMAMOTO, KATSUMI

Jan Little-Washington
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 08/04/2008 appealing from the Office action mailed 02/07/2008.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

6,043,481	Tan et al.	03-2000
6,166,369	Assadi et al.	12-2000
5,396,090	Nakai	03-1995

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claims 1-3, 6, 8-10, 13, and 15-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tan et al. (U.S. Pat. 6,043,481) in view of Assadi et al. (U.S. Pat. 6,166,369).

First, regarding **claim 1**, the Tan reference teaches an image sensor comprising a plurality of pixels formed in a semiconductor substrate (substrate 12), each pixel including a light sensitive element (optoelectronic elements 14), a micro-lens (micro-lens element 18) over each of the light sensitive elements, and a raised ridge structure (ridge elements 19) surrounding each of the micro-lenses, wherein the raised ridge

structure (19) at least partially supports the micro-lens (as shown in Fig. 9b), and further wherein the micro-lens (18) overlays a base portion of the raised ridge structure, as such an overlay is inherent in the reflow process of forming the micro-lens (18) between the ridge elements (19). Please refer to Figs. 4 and 9b, and Col. 3, Lines 35 - Col. 4, Lines 10. What the Tan reference fails to specifically teach is that the raised ridge structure has a triangular cross-section. However, the Assadi reference illustrates in Fig. 3 and discloses in Col. 2, Lines 5-8 and Lines 26-48 an image sensor comprising a raised ridge structure (reflective structure 12) having a triangular cross-section surrounding a micro-lens (micro-lens 24) over a photosensitive device (20). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have included the raised ridge structure having a triangular cross-section, as taught by Assadi, with the image sensor of Tan. One would have been motivated to do so because as Assadi teaches in Col. 2, Lines 42-51, having a raised ridge structure with a reflective triangular cross-section allows more light to be reflected to the micro-lens for diffraction towards the photosensitive device, thereby improving the fill factor of the photosensitive device.

Next, considering **claim 2**, the Tan reference teaches the limitations above, and while Tan does teach that a raised ridge structure (19) is located around the periphery of each micro-lens (18), Tan does not specifically disclose that the raised ridge structure is circular. However, the Assadi reference does teach a raised ridge structure (reflective surfaces 12) that surrounds each micro-lens and circularly arranged around each photosensitive device (20) (See Col. 2, Lines 26-48 and Fig. 3).

As for **claim 3**, again the limitations of claim 1 are taught above, and the Tan reference illustrates in Figs. 4 and 9b that the raised ridge structure (19) confines the micro-lens (18).

Considering **claim 6**, the limitations of claim 1 are taught above, and Tan further discloses that the raised ridge structure (19) is formed from the same material (i.e. the raised ridge structure is part of light transmissive layer member 16) that underlies the micro-lenses (18). See Fig. 4 and Col. 3, Lines 37- 50.

In regard to **claim 8**, as is similarly disclosed above with respect to claim 1, the Tan reference teaches pixel of an image sensor comprising a light sensitive element (optoelectronic elements 14) formed in a semiconductor substrate (substrate 12), a micro-lens (micro-lens element 18) over the light sensitive element, and a raised ridge structure (ridge elements 19) surrounding the micro-lens, wherein the raised ridge structure at least partially supports the micro-lens, wherein the micro-lens (18) overlays a base portion of the raised ridge structure, as such an overlay is inherent in the reflow process of forming the micro-lens (18) between the ridge elements (19). Please refer to Figs. 4 and 9b, and Col. 3, Lines 35 - Col. 4, Lines 10. What the Tan reference fails to specifically teach is that the raised ridge structure has a triangular cross-section. However, the Assadi reference illustrates in Fig. 3 and discloses in Col. 2, Lines 5-8 and Lines 26-48 an image sensor comprising a raised ridge structure (reflective structure 12) having a triangular cross-section surrounding a micro-lens (micro-lens 24) over a photosensitive device (20). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have included the raised ridge structure having a

triangular cross-section, as taught by Assadi, with the image sensor of Tan. One would have been motivated to do so because as Assadi teaches in Col. 2, Lines 42-51, having a raised ridge structure with a reflective triangular cross-section allows more light to be reflected to the micro-lens for diffraction towards the photosensitive device, thereby improving the fill factor of the photosensitive device.

In regard to **claim 9**, Tan in view of Assadi teaches the limitations of claim 8 above, and while Tan does teach that a raised ridge structure (19) is located around the periphery of each micro-lens (18), Tan does not specifically disclose that the raised ridge structure is circular. However, the Assadi reference does teach a raised ridge structure (reflective surfaces 12) that surrounds each micro-lens and circularly arranged around each photosensitive device (20) (See Col. 2, Lines 26-48 and Fig. 3).

Regarding **claim 10**, again the limitations of claim 8 are taught above, and the Tan reference illustrates in Figs. 4 and 9b that the raised ridge structure (19) confines the micro-lens (18).

As for **claim 13**, Tan in view of Assadi teaches the limitations of claim 8 above, and Tan further discloses that the raised ridge structure (19) is formed from the same material (i.e. the raised ridge structure is part of light transmissive layer member 16) that underlies the micro-lenses (18). See Fig. 4 and Col. 3, Lines 37-50.

Next, regarding **claim 15**, Fig. 9B and Col. 5, Lines 20-38 of the Tan reference teaches a method of forming a pixel of an image sensor comprising forming a light sensitive element (14) in a semiconductor substrate (12), forming a top planarizing layer (16) over the light sensitive element, forming a raised ridge structure (19) over the top

planarizing layer, the raised ridge structure encompassing the light sensitive element, and forming a micro-lens (18) within the interior of the raised ridge structure and over the light sensitive element, wherein the raised ridge structure at least partially supports the micro-lens, and further wherein the micro-lens (18) overlays a base portion of the raised ridge structure, as such an overlay is inherent in the reflow process of forming the micro-lens (18) between the ridge elements (19). What the Tan reference fails to specifically teach is that the raised ridge structure has a triangular cross-section, and that the top planarizing layer is isotropically etched to form the raised ridge structure. However, as illustrated in Fig. 3 and disclosed in Col. 2, Lines 5-8, Col. 2, Lines 26-48, and Col. 2, Line 54 - Col. 3, Line 43, the Assadi reference teaches an image sensor comprising a raised ridge structure (reflective structure 12) that is formed by isotropically etching the top planarizing layer (i.e. chemically removing portions of the top planarizing layer in both directions), wherein the raised ridge structure has a triangular cross-section surrounding a micro-lens (micro-lens 24) over a photosensitive device (20). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have included the raised ridge structure having a triangular cross-section, as taught by Assadi, with the image sensor of Tan. One would have been motivated to do so because as Assadi teaches in Col. 2, Lines 42-51, having a raised ridge structure with a reflective triangular cross- section allows more light to be reflected to the micro-lens for diffraction towards the photosensitive device, thereby improving the fill factor of the photosensitive device.

In regard to **claim 16**, the limitations of claim 15 are taught above, and Tan further discloses that tile raised ridge structure (19) is formed in the top planarizing layer (16). Please refer to Figs. 4 and 9B, and Col. 3, Lines 41-45.

Next, considering **claim 17**, the limitations of claim 15 are set forth above, and the Tan reference illustrates in Figs. 4 and 9b that the raised ridge structure (19) confines the micro-lens (18).

As for **claim 18**, again the limitations of claim 15 are taught above, but Tan does not specifically teach that the raised ridge structure is a closed shape. However, as is illustrated in Fig. 2 and taught in Col. 2, Lines 30-34, the Assadi reference discloses that the raised ridge structure is a closed shape (e.g. a circle or orthogonal pattern).

Claims 4 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tan et al. (U.S. Pat. 6,043,481) in view of Assadi et al. (U.S. Pat. 6,166,369) further in view of Appellant's admitted prior art.

In regard to **claims 4 and 11**, the limitations of claims 1 and 8 are respectively taught above, but Tan in view of Assadi does not specifically disclose that the micro-lenses are formed from polymethylmethacrylate or polyglycidylmethacrylate. However, noting Para. [0025] of the Appellant's current specification, the Appellant discloses that the use of acrylics such as polymethylmethacrylate or polyglycidylmethacrylate is common in forming micro-lenses. Thus, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have formed the micro-lenses of Tan in view of Assadi using polymethylmethacrylate or polyglycidylmethacrylate. One

would have been motivated to do so because the use of common materials reduces manufacturing costs and the need for additional specialized manufacturing equipment.

Claims 5, 7, 12, 14, and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tan et al. (U.S. Pat. 6,043,481) in view of Assadi et al. (U.S. Pat. 6,166,369) further in view of Nakai (U.S. Pat. 5,396,090).

Next, considering **claim 5**, the limitations of claim 1 are taught above by Tan in view of Assadi, but the combination fails to specifically disclose that the raised ridge structures have a height of about 0.2 microns. However, the Nakai reference teaches an image sensor having a plurality of micro-lenses (66) surrounded by a raised ridge structure (partition wall 51), wherein the partition wall 51 can have a height of 0.2 microns, as taught in Figs. 1 and 5, and Col. 4, Line 46 - Col. 5, Line 50. It would have been obvious to one of ordinary skill in the art at the time the invention was made to have incorporated the raised ridge structure having a height of 0.2 microns, as taught by Nakai, with the raised ridge structure of Tan in view of Assadi. One would have been motivated to do so because by limiting the height of the raised ridge structure, the dimensions of the image sensor can remain small, therefore allowing for use in compact imaging devices.

As for **claim 7**, again the limitations of claim 1 are taught above, but Tan in view of Assadi does not disclose the use of a color filter layer between the micro-lenses and the light sensitive elements. However, the Nakai reference teaches the use of a color filter layer in the image sensor in Col. 6, Lines 28-31.

Regarding **claim 12**, the limitations of claim 8 are taught above, but Tan in view of Assadi fails to specifically disclose that the raised ridge structures have a height of about 0.2 microns. However, the Nakai reference teaches an image sensor having a plurality of micro-lenses (66) surrounded by a raised ridge structure (partition wall 51), wherein the partition wall 51 can have a height of 0.2 microns, as taught in Figs. 1 and 5, and Col. 4, Line 46 - Col. 5, Line 50.

In regard to **claim 14**, again the limitations of claim 8 are taught above, but Tan in view of Assadi does not disclose the use of a color filter layer between the micro-lenses and the light sensitive elements. However, the Nakai reference teaches the use of a color filter layer in the image sensor in Col. 6, Lines 28-31.

Finally, considering **claim 19**, Tan teaches the limitations of claim 15, but the method of Tan in view of Assadi fails to teach the use of a color filter layer between the micro-lenses and the light sensitive elements. However, the Nakai reference teaches the use of a color filter layer in the image sensor in Col. 6, Lines 28-31.

(10) Response to Argument

First in regard to claims 1, 8 and 15, the Appellant submits that the combination of Tan in view of Assadi is improper. This is because combining Tan with Assadi makes Assadi unsatisfactory for its intended purpose (Section A. Improper Combination, pg. 6 – 7). The Examiner respectfully disagrees.

Specifically, noting the Tan reference teaches the purpose of the ridges is to separate the microlenses from each other (Col. 4, lines 1 – 8 of Tan). Tan (Fig. 4 and

9B) further teaches the contoured surface (10) has ridge elements (19); each ridge (19) is associated with one optoelectronic element (14). Tan teaches that the ridge (19) operates to prevent contact of micro lens elements (18) peripheries or other merging of the discrete lens elements in the array (Col. 4, lines 4 – 8). The ridge elements (19) of the contour surface (10) of Tan (Fig. 4) do not appear to have a triangular cross-section specified as claimed. Tan teaches an image sensor device for collecting, transmitting and detecting light such that light collection is maximized, and light loss minimized (Col. 2, lines 25 – 27). Tan teaches the contoured surface provides lateral guides for microlens spacing (Col. 2, lines 43 – 44). The lateral spacing guides facilitate maximum packing of lens elements, such optimized packing is commonly referred to as "maximum fill factor" (Col. 2, lines 44 – 47).

On the other hand the Assadi reference (Fig. 3) teaches and shows a ridge element that has a triangular cross-section (12 of Fig. 3). Assadi (Fig. 3) teaches a microlens (24) has been formed over the semiconductor structure (14). As a result, light reflected from the reflective surfaces (12) may then be diffracted by the microlens (24), as illustrated, towards the photosensitive device (20). In this way, the reflective surfaces (12) and the microlens (24) work together to improve the fill factor of the photosensitive device (20). As pixel sizes become smaller the reflective micro-structure becomes more effective in increasing the light collection efficiency (Col. 2, lines 42 – 53). Assadi teaches a continuing need for improved ways to collect incident light and to focus the greatest possible amount of that light on the photodetectors which form an imaging array Col. 1, lines 36 – 39).

On page 7 of the Appeal (section A) the Appellant argues a person of ordinary skill were to combine the ridges in Tan with the reflective surfaces in Assadi more light would not be reflected to the microlens 24 of Tan. Appellant further argues that to the contrary, during the reflow process the microlens would take up space on the reflective surface 12 and as a result, less light would be reflected to the microlens. This would defeat the purpose of Tan, which is to increase the amount of light reflected to the microlens (Section A. Improper Combination, page 7). Assadi teaches the reflective surfaces (12) and the microlens (24) work together to improve the fill factor of the photosensitive device (20) (Col. 2, lines 42 – 53) and Tan teaches the lateral spacing guides facilitate maximum packing of lens elements, such optimized packing is commonly referred to as "maximum fill factor" (Col. 2, lines 42 – 47). For this reason, the Examiner believes that Tan in view of Assadi do teach the limitations of claims 1, 8 and 15 and are the combination of Tan and Assadi would not make Assadi unsatisfactory for its intended purpose.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

/Christopher K. Peterson/

Conferees:

Ngoc-Yen Vu

/Ngoc-Yen Vu/
Supervisory Patent Examiner Art Unit 2622

David Ometz
/David L. Ometz/

Supervisory Patent Examiner, Art Unit 2622